

AGRI-FACTS

Practical Information for Alberta's Agriculture Industry

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Agdex 716 (B36)

Aeration of Dugouts or Ponds with Compressed Air

Dugout aeration improves water quality by maintaining dissolved oxygen levels. Of all the methods used for improving dugout water quality while it is in the dugout, aeration is the most effective and practical technique.

Background

Dugouts most often contain algae and water weeds. This plant life decays as it dies, creating a layer of organic matter on the bottom of the dugout. The aerobic decomposition of this organic matter consumes dissolved oxygen in the dugout water.

During the summer, oxygen in the dugout water is usually replenished from the atmosphere. In the winter, ice covering the dugout prevents this process. Once the dissolved oxygen is exhausted, anaerobic decomposition (decay without oxygen) begins.

Hydrogen sulfide gas is produced by this process, causing the water to become black and smelly. An "acid like" condition is created, causing more minerals and nutrients to be dissolved into the water from bottom sediments.

This cycling of nutrients will cause additional plant and algae growth within the dugout. The problem of anaerobic decomposition may even occur in well maintained dugouts during the winter and summer. Aerating the dugout is the only practical solution.

Aeration ensures a sufficient level of dissolved oxygen in the water to control odors and to maintain good water quality by preventing anaerobic decomposition. Continuous aeration year round will maintain good water quality and reduce algae growth by preventing the recycling of nutrients. Aeration also enhances the

conditions for zooplankton to consume algae, thus providing additional algae control.

Although aeration may reduce the plant and algae problem, a certain amount of chemical treatment of weeds and algae may still be required (see Alberta Agriculture and Forestry's Agdex 716 (B31), *Quality Farm Dugouts*). It is also important to try to control the quality of runoff entering the dugout. Nutrient-rich sediment in runoff can cause a tremendous increase in algae and weed growth.

*Aeration year
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Planning considerations

There are many effective ways to aerate farm dugouts. However, all aeration systems and techniques have limitations.

When planning an aeration system for your dugout, consider the following:

- dugout size and depth
- dugout use (i.e. fish, livestock, household, etc.)
- distances and costs for mainline electrical power
- wind exposure and average wind speeds in your area
- the feasibility of snow clearing for aeration by photosynthesis and safety (i.e. thin ice)
- perforated air hose diffusers or membranes to increase aeration system efficiencies
- check valves and moisture traps to prevent shallow buried air lines from freezing
- deep burial versus shallow buried air lines
- purchasing a dissolved oxygen test kit for dugouts stocked with fish

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Evaluation of aeration systems

Surface water sources, including dugouts, receive oxygen many ways, both naturally and artificially. In the summer months, oxygen is added to dugout water by both wind and wave action as well as from the photosynthesis of growing plants. In winter, ice and snow cover the dugout, almost completely stopping these natural processes.

In most areas, it is not practical to clear snow from the ice to enhance natural aeration by photosynthesis. Air can also be added artificially by circulating the water or by pumping air into it.

There is considerable debate between researchers and manufacturers of aeration equipment as to the most efficient and effective way of aerating farm dugouts. Part of this debate results from the fact that dugouts vary dramatically in size, depth and water quality. Since 1995, the Prairie Farm Rehabilitation Administration (PFRA), the University of Alberta (U of A) and Alberta Agriculture and Forestry's (AF) have been working on several joint research projects to address these issues.

A study completed by the Alberta Farm Machinery Research Centre (AFMRC) in 1995 compared the effectiveness of three different air injection/diffuser devices including an open-ended 3/8 inch diameter hose, an airstone and a perforated hose. Results showed that the open-ended hose injector required three times the amount of air to saturate the water with dissolved oxygen than did the airstone or perforated hose.

Researchers concluded that proper diffusion of air into water plays a significant role in how efficiently an air aeration system dissolves oxygen into water. See Figure 1 and Figure 2.

An extensive study was done in the Peace River Region by PFRA, U of A and AARD, which tested both air injection devices and mechanical surface aeration. A total of 18 dugouts were studied over three years. Air injection systems were tested using three types of diffusers:

- open-ended hose
- linear fine bubble diffuser
- membrane diffuser

Study results revealed the following:

- anoxia (i.e. black smelly water condition) can develop in the bottom of dugouts in both summer and winter
- aeration removes the foul smelling hydrogen sulfide gas odor and prevents anoxia from occurring
- the aeration devices tested only circulate and aerate water above the device
- diffusers that create fine bubbles are more efficient at circulating and aerating water than the large bubbles produced by open-ended hoses or hoses perforated with 1/8 inch diameter holes
- air injection devices were more effective than surface aerators that mechanically mix the water

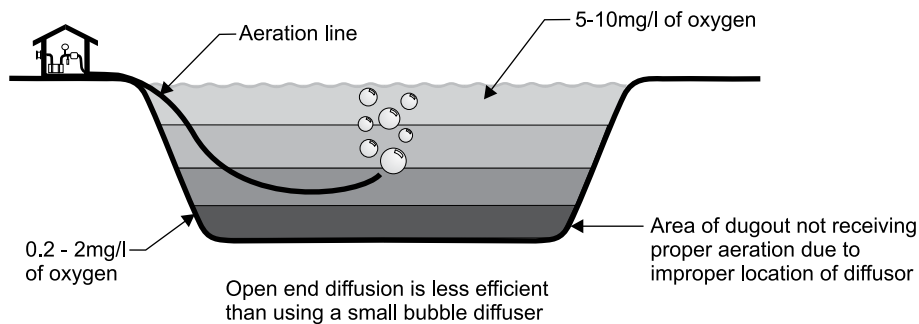


Figure 1

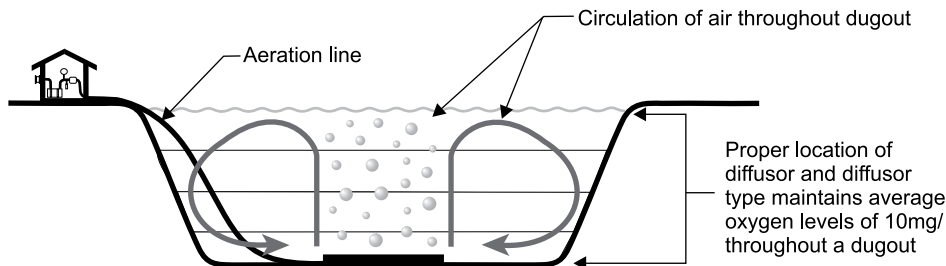


Figure 2

Figure 1 shows the effects of improper installation of an aeration line or of having no diffuser. Not weighing down the line creates high oxygen levels at the top of the dugout and low oxygen levels at the bottom. Not sloping and burying the aeration line can allow ice to plug the line in winter. The aeration line should be located as close to the bottom of the dugout as possible. This placement will ensure proper aeration and circulation of oxygen. An open-ended hose is less efficient than using a small bubble diffuser.

Figure 2 illustrates the benefits of proper installation and diffuser selection. This type of system maintains proper oxygen levels throughout the dugout.

Types of aeration systems

There are two effective power types available with aeration systems: wind powered and electrically powered. Floating systems use a propeller-like device to mix the water. For the purposes of dugout aeration, these systems are not as practical or effective for Alberta conditions.

Most dugout situations use compressed air aeration systems, and they can be quite effective if selected and installed correctly. There are four main components to this type of system:

- power supply
- air compressor
- aeration line to convey air from the pump to the dugout
- a diffuser to release air into the water

Bank-mounted windmills use a diaphragm-type compressor to pump air into an aeration hose that extends to the bottom of the dugout. Windmills are an ideal choice for areas with suitable wind conditions and remote sites where electrical power is too costly to install. However, windmills perform poorly on sites where a combination of hills, trees, low dugout water levels and deep dugouts (over 20 feet) exist.

Several types of electrically-powered air compressors are available. The most commonly used and preferred are oil-less diaphragms or piston pumps. These compressors are quiet, relatively inexpensive to purchase and operate, and they require little maintenance. When choosing a pump, it is important to check the specifications to ensure it is rated for continuous use.

Oil-type compressors are not recommended for a permanent aeration system. They are not rated for continuous use and require constant monitoring and maintenance. As a rule, a diaphragm-type compressor that pumps approximately one cubic foot per minute (cfm) for every one million gallons of dugout water is sufficient.

Compressors should be housed in a heated shop or pump house to protect the motor and diaphragm from the cold. This housing also protects the electrical connections from moisture buildup. Solar-powered electric compressors are also available; however, sunlight and battery storage are limiting factors during the winter months.

Installation

Proper line installation takes into consideration the location of the system and the environmental conditions. Some factors to consider:

- sunlight tends to break down exposed plastic lines
- aeration lines placed above the frost line are prone to condensation and freezing
- equipment, ice and animals can all cause damage to the line

When constructing a **new dugout**, it is often possible to bury the aeration line below the frost level in the same trench as the water line. The water line may go to a still well with the pump whereas the air line would go to where the air pump is located.

For existing dugouts, bury the air line at least 300 mm (12 inches) to reduce potential damage. Install the line with a continuous slope down from the compressor into the dugout. This installation will drain moisture into the dugout rather than having it accumulate in the line.

The installation of a check valve will reduce the possibility of any water backing up into the line. A spring-loaded check valve capable of sealing at low pressure is best. Placing the pump within a small shed or pump house will also reduce condensation problems as will installing a condensation vessel (moisture trap) near the pump. See Figure 3.

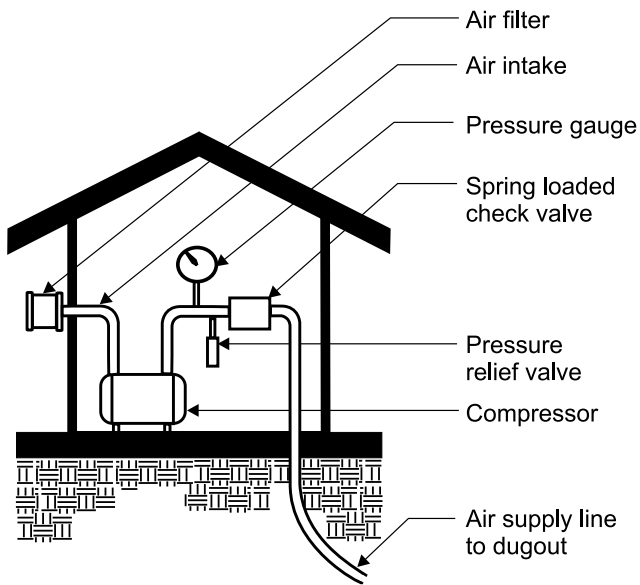


Figure 3. Compressor installation details

Diffuser selection and installation

A diffuser is the key component in the efficiency of the aeration system. Its purpose is to distribute the air over a wide portion of the dugout and increase the amount of contact the air has with water.

Three basic types of diffusers are commercially available:

- airstones
- membrane
- linear (die-cut)

If selecting an airstone, ensure that it is matched to the pump output and designed for dugout aeration. Airstones should be cleaned at least once a year to remove any buildup. A wire brush or sandpaper can be used. Test the airflow in a barrel of water first before putting the airstone back into the dugout to ensure full airflow.

Membrane diffusers are custom made from rubber tubing with fine slits in it. Like the airstone, they can produce fine bubbles. They are often flexible enough to stretch and self-clean, but an annual cleaning and checkup should still be done. Soaker hoses used for irrigation are not suitable for use as a membrane diffuser.

Commercial linear diffusers are made from 1/2 inch diameter plastic tubing with 1/4 inch slits cut along it, approximately every 4 inches. Some have a weighted keel attached. These diffusers can be quite effective, but they should be cleaned twice a year to remove any mineral buildup on the slits.

A “homemade” version of the linear diffuser has been used for many years. Although this version produces larger bubbles, it can be quite effective and resistant to plugging.

It is made from up to 50 feet of 1/2 inch PE pipe with 1/16 inch holes drilled into it. Evenly space and drill 12 holes for every 1 cfm of compressor capacity. Plug the end with a removable cap or shut-off valve for maintenance purposes. A metal cable fastened to the aeration line or linear diffuser with plastic ties will keep the line on the bottom for maximum benefit. Attach a piece of poly rope to the end so that the end can be retrieved and the pipe hauled up for maintenance or checking.

A floating intake for the water line is recommended (see Alberta Agriculture’s Agdex 716 (B34), *Float Suspended Intake for Dugouts*). Ensure that the diffuser is not located directly below the floating intake as this situation will potentially cause the water line to float as well as damage the water pump.

Troubleshooting

A pressure gauge can help with troubleshooting problems. Fluctuating air pressure could indicate a problem with the pump and impending failure. An increase in air pressure could indicate that the air line or diffuser is plugged with debris, ice or a buildup of scale.

If a linear diffuser is used, bubbles should be seen along the full length of the line. Any lack of consistency could indicate debris or the short circuiting of air out of the remaining holes.

In the event of an air line blockage, a pressure relief valve, installed at the compressor outlet, can prevent damage to both the compressor and the air line added either by circulating the water or by pumping air into it.

Dugouts with fish

If the dugout is stocked with fish, the concept of aeration does not change, but the type of aeration may be important. Windmill systems, although energy efficient, are not recommended for dugouts or ponds containing fish. If using an electric pump system, it is important to check the specifications of the pump to ensure it is rated for continuous use, which is crucial for fish survival in the dugout.

A sufficient pump for fish-stocked ponds or dugouts should provide at least 1 cfm at 20 psi for 1,000,000 imperial gallons of water (or maintain an oxygen level of more than 4 ppm in water). A simple oxygen testing kit can be purchased to monitor oxygen levels in water (approximately \$140).

Aeration by photosynthesis

Plants produce oxygen in the dugout while they are alive and are able to utilize the sun's rays. When a dugout is covered with snow, the snow layer can reduce the amount of sunlight the plants receive, thus contributing to low oxygen production.

If it can be done safely, try removing the accumulated snow cover to allow additional sunlight to penetrate the ice on your dugout for plant use. **Warning: only attempt this removal in safe ice areas to prevent accidents or death.**

Safety

During the winter, dugout aeration systems can result in open and/or weak areas in the dugout ice. These conditions can be very dangerous to young children and people snowmobiling at night. It is important to educate young children about these hazards and post the area with highly visible warning signs.

Remember that continuous dugout aeration is essential to maintain dugout water quality year round. Dugout aeration is an important first step in improving dugout water quality.

More information

Additional information is available through agricultural water specialists or on the Alberta Agriculture and Forestry's website www.agriculture.gov.ab.ca

Agricultural water specialists can be contacted through the Alberta Ag-Info Centre by calling toll-free: 310- FARM (3276).